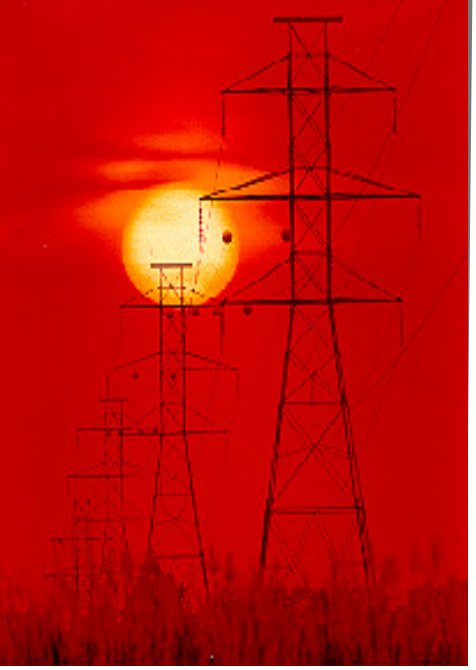

Data and Data Sharing for DRP

Smart Inverters – Data Specifications and Use Cases

April 13, 2015

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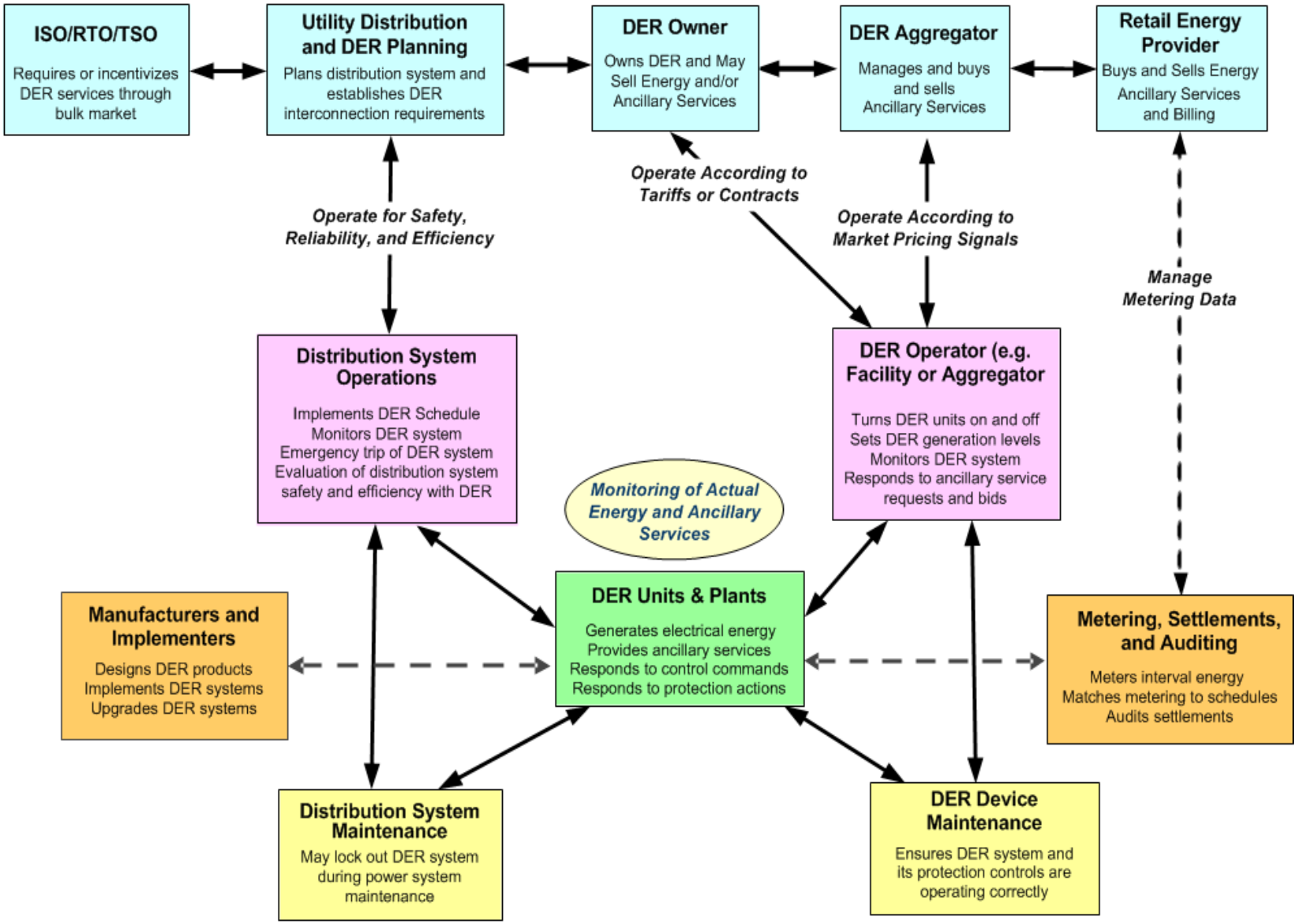
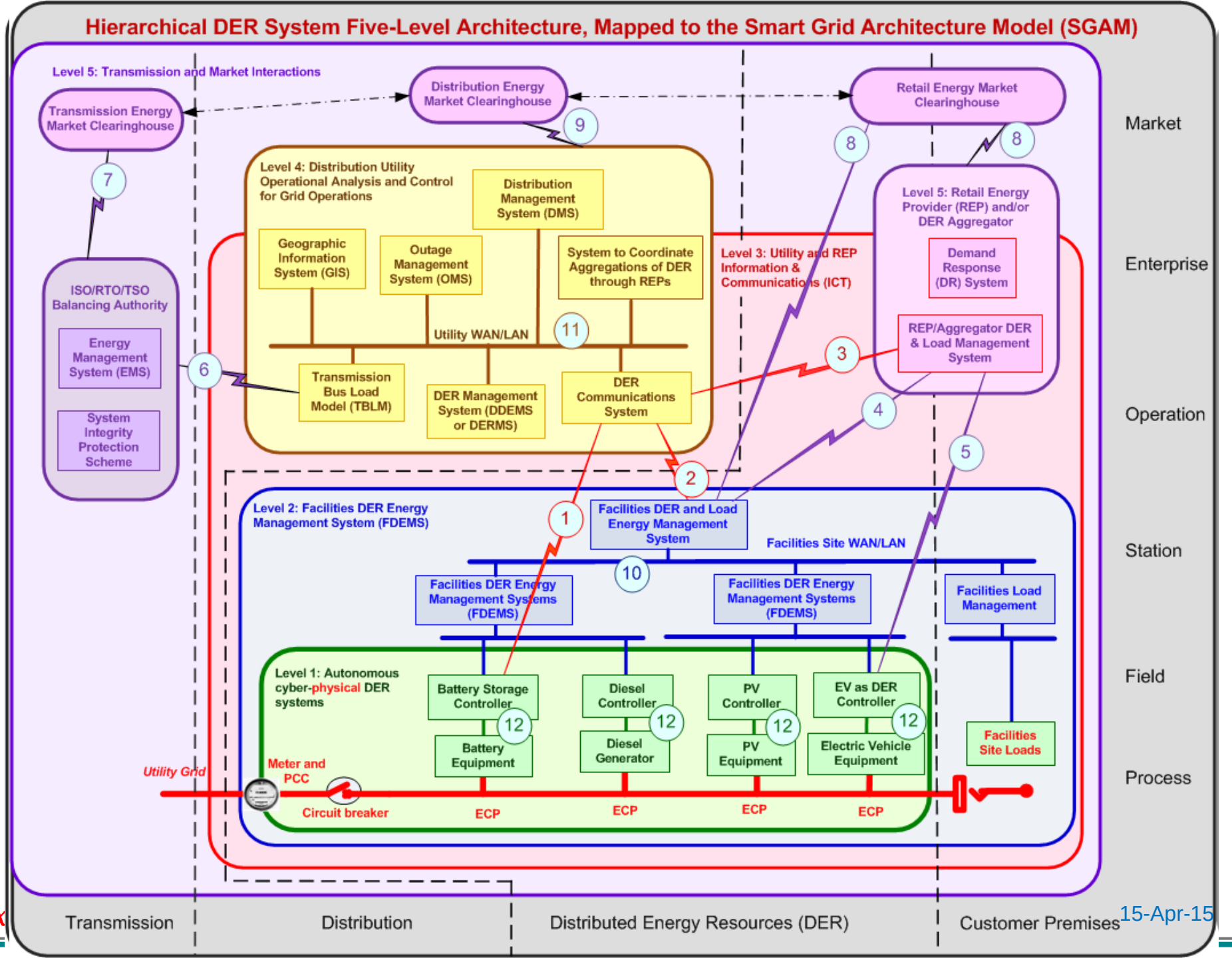
Topics

- Stakeholders and DER Configurations
- Smart Inverter Working Group (SIWG) and Data Requirements
- IEC 61850 as Information Model to Provide Interoperability
- IEEE 2030.5 (SEP2) as Default Protocol

Challenge: Large Numbers of Disparate DER Stakeholders




Hierarchical DER System Five-Level Architecture, Mapped to the Smart Grid Architecture Model (SGAM)
Level 5: Transmission and Market Interactions
Transmission Energy Market Clearinghouse
Distribution Energy Market Clearinghouse
Retail Energy Market Clearinghouse
Market
Level 4: Distribution Utility Operational Analysis and Control for Grid Operations
Distribution Management System (DMS)
Geographic Information System (GIS)
Outage Management System (OMS)
System to Coordinate Aggregations of DER through REPs
Utility WAN/LAN
Level 3: Utility and REP Information & Communications (ICT)
Level 5: Retail Energy Provider (REP) and/or DER Aggregator
Demand Response (DR) System
REP/Aggregator DER & Load Management System
Enterprise
ISO/RTO/TSO Balancing Authority
Energy Management System (EMS)
System Integrity Protection Scheme
Transmission Bus Load Model (TBLM)
DER Management System (DDEMS or DERMS)
DER Communications System
Operation
Level 2: Facilities DER Energy Management System (FDEMS)
Facilities DER and Load Energy Management System
Facilities Site WAN/LAN
Facilities DER Energy Management Systems (FDEMS)
Facilities DER Energy Management Systems (FDEMS)
Facilities Load Management
Station
Level 1: Autonomous cyber-physical DER systems
Battery Storage Controller
Diesel Controller
PV Controller
EV as DER Controller
Battery Equipment
Diesel Generator
PV Equipment
Electric Vehicle Equipment
Facilities Site Loads
Field
Utility Grid
Meter and PCC
Circuit breaker
ECP
ECP
ECP
ECP
Process
1
2
3
4
5
6
7
8
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12
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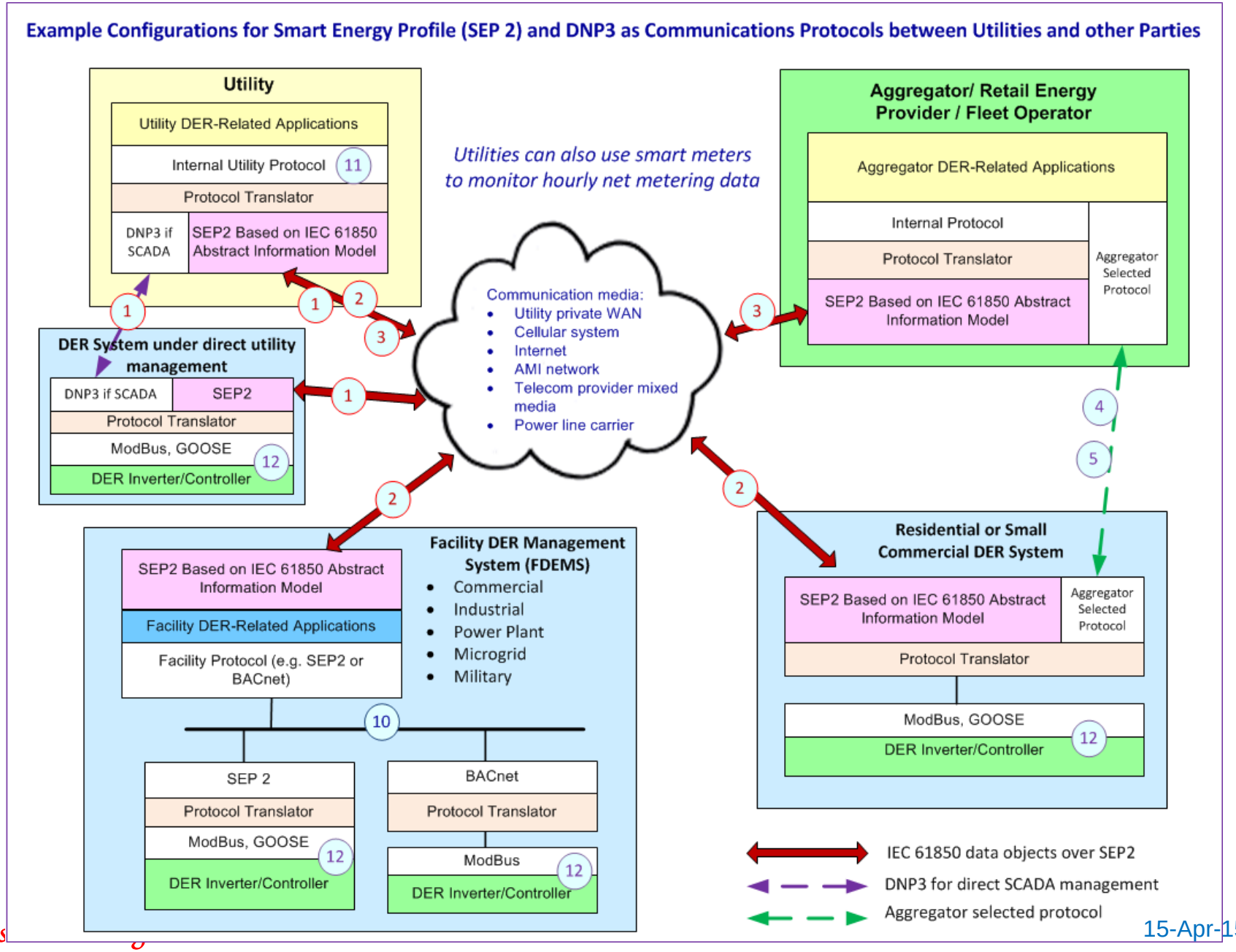
12
12
Transmission
Distribution
Distributed Energy Resources (DER)
Customer Premises

Smart Inverter Working Group (SIWG)

- The SIWG developed a phased approach of recommendations to the CPUC:
  - **Phase 1**: Seven (7) critical autonomous functions – ***approved by CPUC in December 2014 to be mandatory around mid 2016***
  - **Phase 2**: Communications capabilities for monitoring, updating settings, and control –***submitted to the CPUC in late February, 2015***
  - **Phase 3**: Additional DER functions – currently being discussed – ***open to all who want to address these technical DER capabilities***
- SIWG members now participating in a survey on the importance of about **40+ DER** functions and use cases
- **SIWG DER functions will provide many of the DRP services** being discussed in the DRP process

SIWG Phase 2 Communications and Data Requirements



Data from Facilities and Aggregators

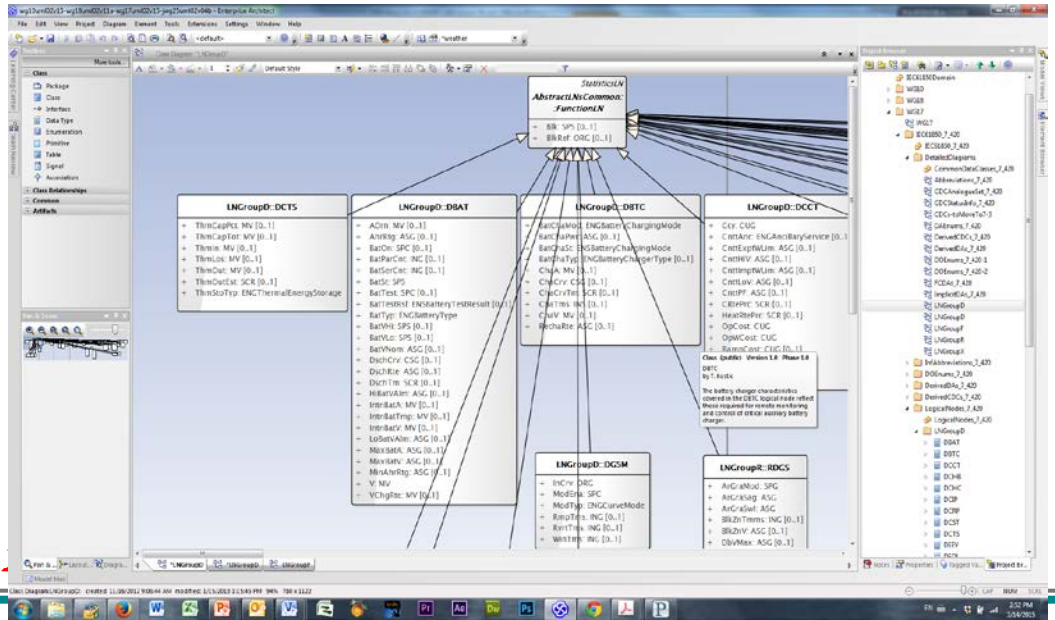
- DRP planning and distribution operations will require visibility at **feeder level circuits, not substation level**
  - DER impacts (negative and positive) take place locally, but can have system-wide effects
  - **Real-time or near-real time data**, with confidentiality and/or in aggregate to protect privacy, can provide critical time-stamped information, including max, min, average, alarms
  - **Control commands and setting updates** can significantly enhance DER capabilities, with authorization, authentication, integrity to provide cyber security
  - **Analysis of trends and forecasts**, based on aggregated and locally forecast data, can provide significant value for modeling, planning, and scheduling
  - This analysis can also determine locational value, improve interconnection planning, and suggest **optimal mixes of DER services and capabilities**
  - Ultimately, as DRPs become more sophisticated, **real-time operations will become part of the planning requirements to ensure reliability and increase carrying capacity**

SIWG Phase 3 DER Functions

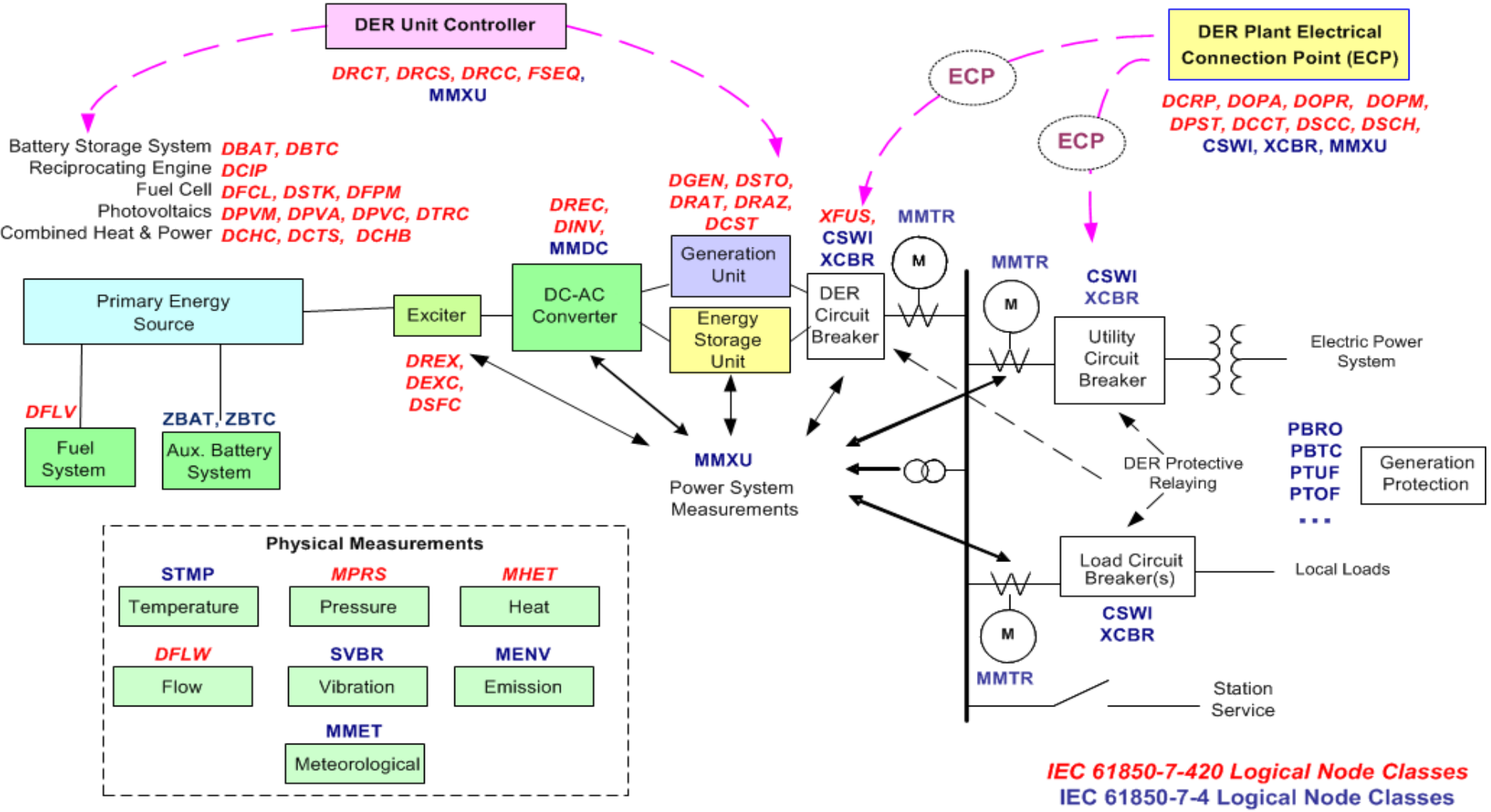
- Discussions on relative importance of **40+ DER functions**, which need further technical resolutions, which should be included in Rule 21, and what are their data exchange requirements.
- Some of Phase 3 functions include:
  - Provide status and measurements
  - Set actual real power output
  - Limit maximum real power output
  - Frequency-watt
  - Voltage-watt
  - Power-power factor
  - Schedule actual or maximum real power output
  - Frequency smoothing
  - Automatic Generation Control (AGC)

IEC 61850 as UML-based Abstract Information Model

- **IEC 61850 is the international information model standard** for “smart” DER data
- IEC 61850 is now modelled in UML (Unified Modeling Language)
- UML model allows extractions of different formats, such as MMS (current standard) or XML/XER XSDs (Internet standard)
- **UML model provides a single standard source of data objects**, thus minimizing the risk of inconsistencies in implementations
- Data objects can be used over different service and transport protocols, including XMPP (planned 61850-8-2 standard)



Overview: IEC 61850 Logical Nodes for Distributed Energy Resource (DER) Systems

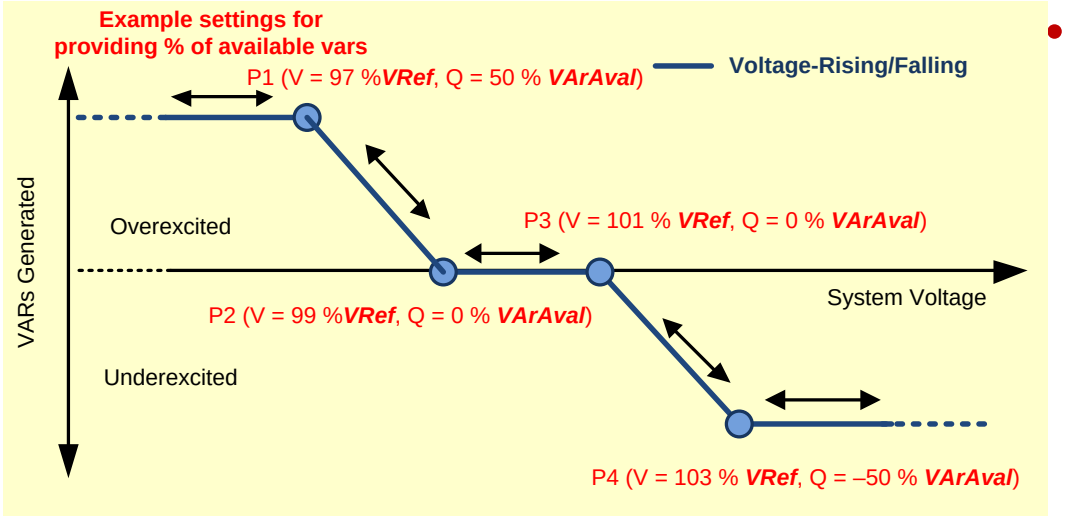


Energy Converter = Microturbines, Fuel Cell, Photovoltaic System, Wind turbines, Diesel Generators, Combustion Turbines

Storage Device = Battery, Pumped Hydro, Superconducting Magnetic Energy Storage, Flywheels, Micro flywheels

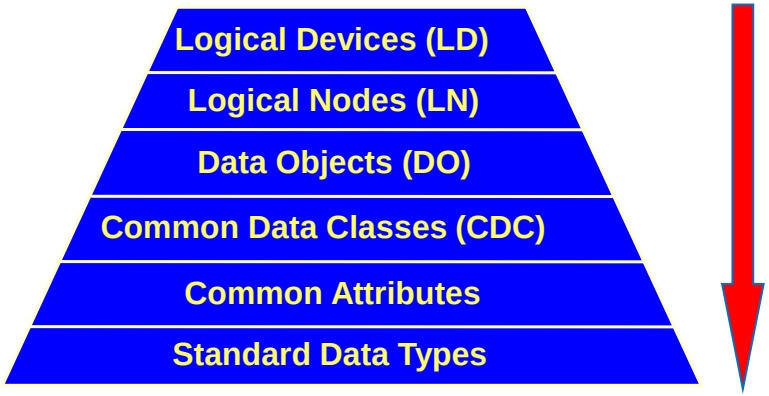
Converter = DC to AC, frequency conversion, voltage level conversion
Auxiliaries = Battery, Fuel Cell

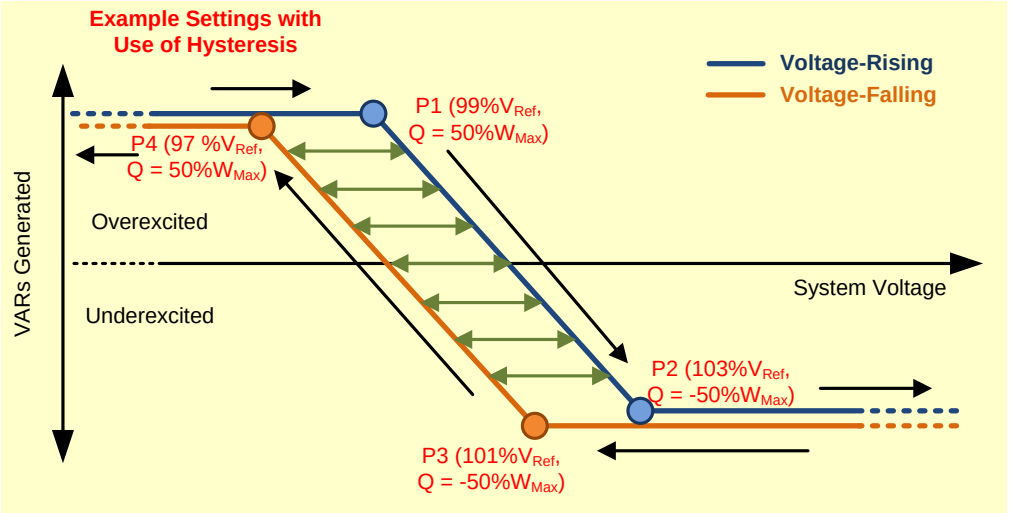
IEC 61850-90-7 Volt-Var Curves: Basic Curve and with Hysteresis



- **IEC 61850 provides well-known names and structures** of data objects:
  - V = voltage
  - Vref = reference voltage
  - VArAval = available vars
  - WMax = maximum watts
  - PF = power factor

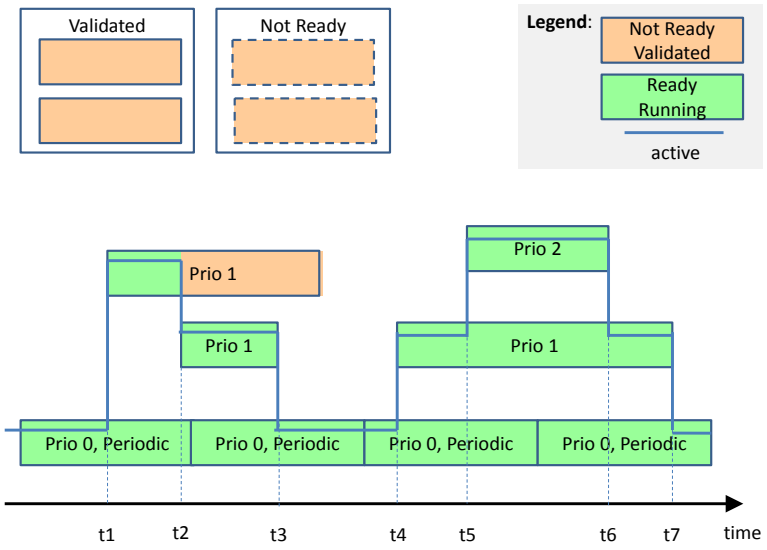
- IEC 61850 modeling structures:





IEC 61850-90-10: Scheduling

- Schedules:
  - Time-based schedules for going into specific modes
    - From 6am to noon, turn on and use mode 3
    - From noon to 5:30, use mode 5
    - From 5:30 to 7:15, use mode 8
    - At 7:15, turn off
    - Repeat schedule every weekday during the summer
  - Schedules have priorities and can be overridden by emergencies or other commands



SIWG Default Protocol: IEEE 2030.5/SEP2

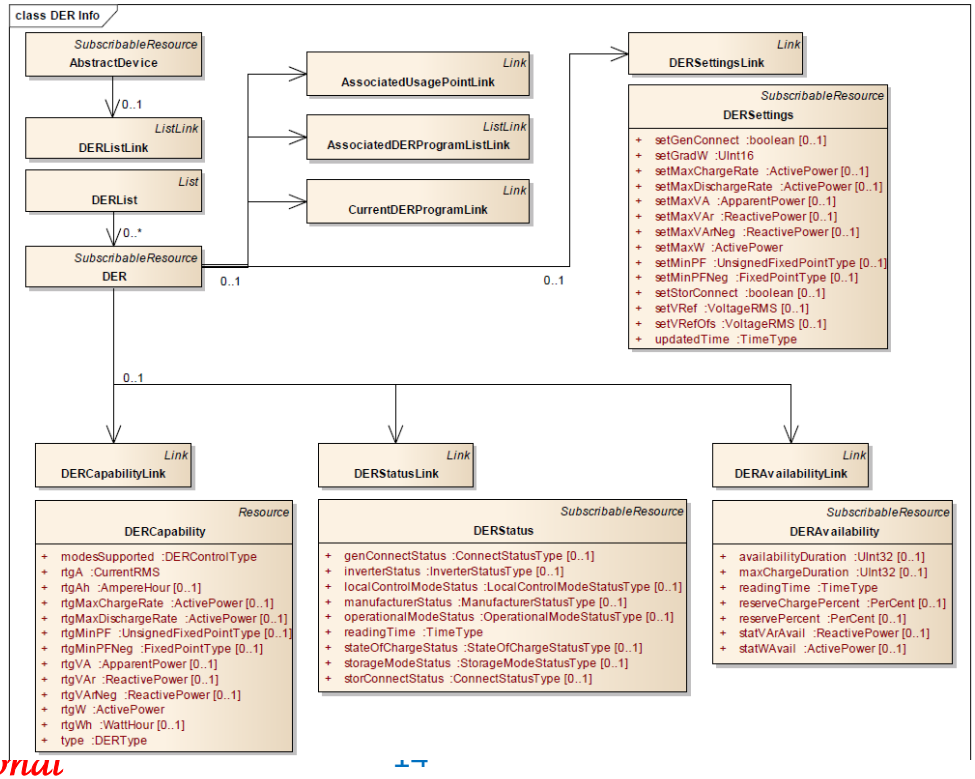
- SEP2 is an evolution of ZigBee Smart Energy 1.x, but SEP2 is not ZigBee
- MAC/PHY (link layer) independent (internetworking) – intended to run over generic Internet Protocol stack – become one of the protocols for the “Internet of Things”
- Focus on communications related to efficiency, usage, price communication, demand response and load control, and messaging
- Complete protocol security is specified
- Optimized for embedded and battery-powered devices
- Range of backhaul (AMI, Internet, etc.) bandwidths and cost kept in mind during development
- Submitted and approved as IEEE 2030.5™-2013
- Consortium for SEP 2 Interoperability (CSEP) established
- Conducting final testing and certification

DER Package in IEEE 2030.5 / SEP2

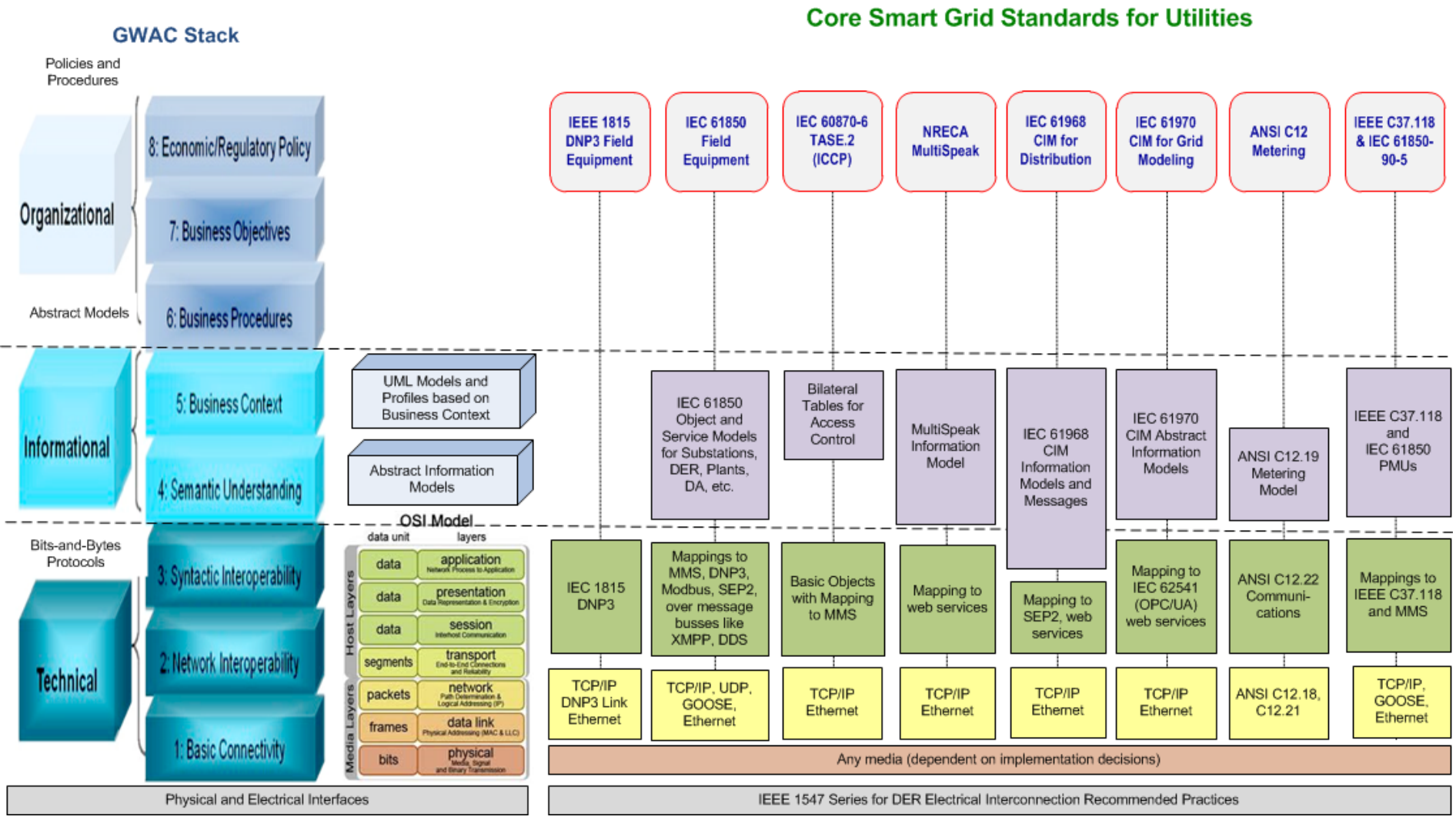
- Derived from IEC 61850-90-7, but re-formatted to be consistent with SEP2 style
- Just like IEC 61850, modeled in UML
- Can extract XSDs from the UML model

15.1.21 **DER Package**

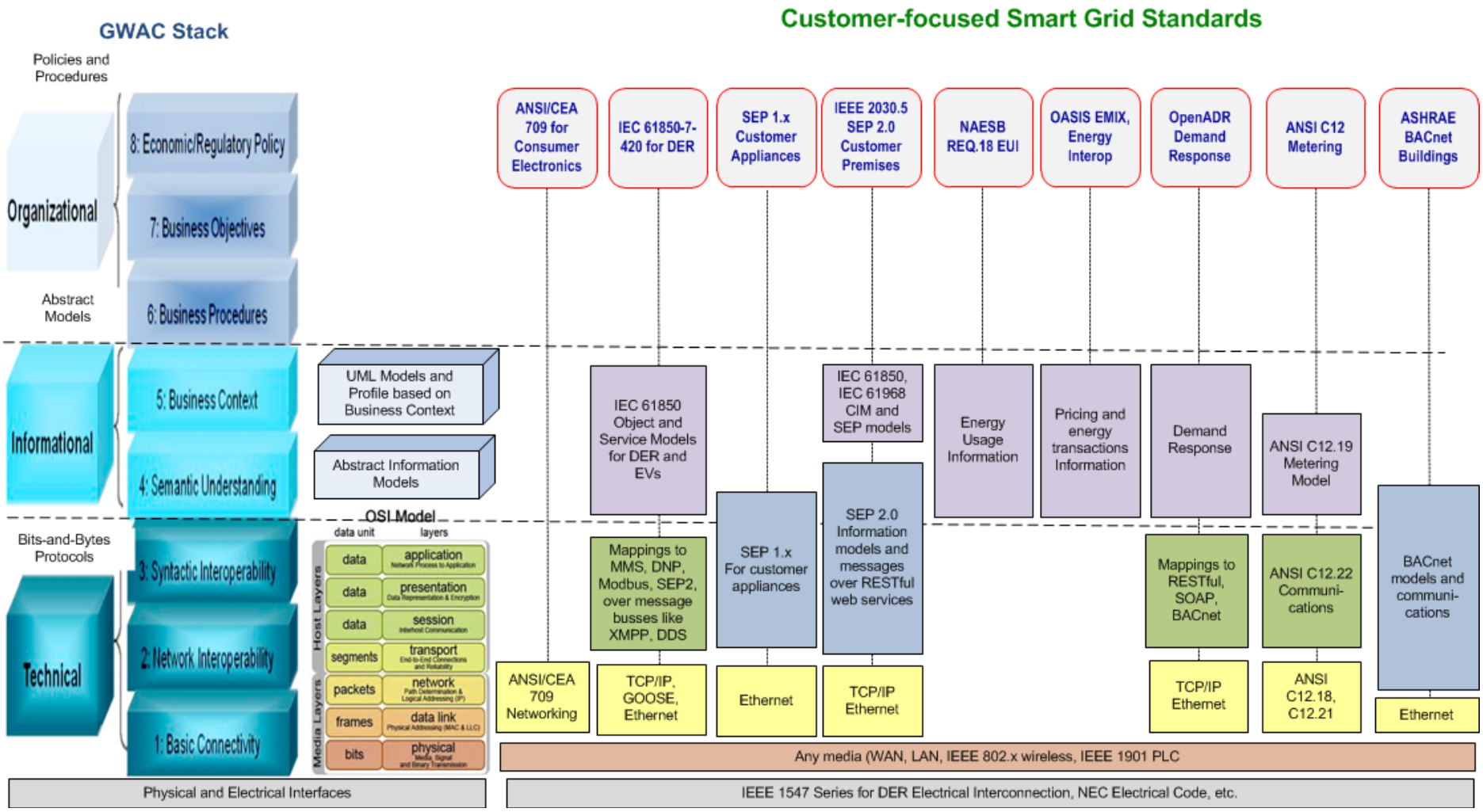
Contains definitions related to allowing distributed energy resources to provide energy back to the grid.

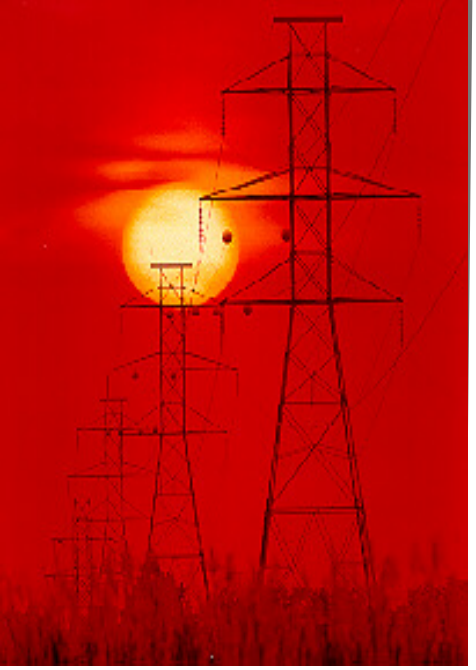


Core Smart Grid Standards for Utilities



Customer-focused Smart Grid Standards





Questions?

Standards are the Solution for Interoperability

(The only problem is that there are so many standards to choose from!)

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